Narrow Linewidth 780 nm Distributed Feedback Lasers for Cold Atom Quantum Technology

A. Saeed[1], Y. Ding[1], G. Ternent[2], B. Casey[2], C.J. Hamilton[3], N. Hempler[3], G.P.A. Malcolm[3], G.T. Maker[3], M. Sorel[1] and D.J. Paul[1]

1. *University of Glasgow, School of Engineering, Rankine Building, Oakfield Avenue, Glasgow, G12 8LT, U.K.*
2. *Kelvin Nanotechnology Ltd., Oakfield Avenue, Glasgow, G12 8LT, U.K.*
2. *M Squared Lasers Ltd, 1 Kelvin Campus, West of Scotland Science Park, Maryhill Road, Glasgow, G20 0SP, U.K.*

Cold atom quantum technology systems have a wide range of potential applications which includes atomic clocks, rotational sensors, inertial sensors, quantum navigators, magnetometers and gravimeters. The UK Quantum Technology Hub in Sensors and Metrology has the aim of developing miniature cold atom systems using an approach similar to that pioneered by the chip scale atomic clock where microfabricated vacuum chambers have atomic transitions excited and probed by lasers. Whilst narrow linewidth Ti:Sa and external cavity diode lasers have been required for cooling and control, such lasers are too large, power hungry and expensive for future miniature cold atom systems.
Here we demonstrate 1 mm long 780.24 nm GaAs/AlGaAs distributed feedback (DFB) lasers aimed at ^{87}Rb cold atom systems operating at 20 ˚C with over 50 mW of power and side-mode suppression ratios of 46 dB using sidewall gratings and no regrowth. Rb spectroscopy is used to demonstrate linewidths below the required 6.07 MHz natural linewidth of the ^{87}Rb D_2 optical transition used for cooling. Initial packaged fibre-coupled devices demonstrate lifetimes greater than 200 hours. We also investigate the use of integrated semiconductor amplifiers (SOAs) and longer devices to further reduce the linewidths well below 1 MHz. A range of options to control the populations of electrons in the hyperfine split energy levels spaced by 3.417 GHz are examined. Two integrated lasers, integrated electro-absorption modulators (EAMs) and the direct modulation of a single DFB laser approaches are investigated and we will discuss which is best suited to integrated cold atom systems.